EXPERIMENTS, MODELING, AND SIMULATION
OF THE SUPERELASTIC EFFECT IN SHAPE-MEMORY ALLOYS

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This work concerns an integrated experimental, theoretical, and computational study of the superelastic effect in shape-memory alloys under multiaxial loading conditions. The experimental component involves a series of finite-deformation tension-torsion tests conducted on thin-walled polycrystalline Nitinol tubes. The theoretical habit-plane model adopts many salient features of classical multi-surface plasticity, yet departs from the latter in substantial ways. The model also incorporates the effect of texture and captures key experimentally observed features, such as the sharp change in stress-strain response due to non-proportionality of the loading. The algorithmic approach also departs from that of multi-surface plasticity in a fundamental way: the operator-split strategy is replaced by an active set strategy that allows for the uniform treatment of elastic loading/unloading and forward transformation processes. This is complemented by an analogous treatment for the elastic reloading/unloading and reverse transformation processes. In addition, an automatic selection/deselection scheme is employed to identify the potentially active martensitic variants. Numerical simulations are presented for thin-walled tubes in tension-torsion, as well as for biomedical stents in compression-tension cycles.